Presence of *podisus congrex* (stål 1862) (h*emiptera: pentatomidae*) in relation to weed management in the avocado crop of Risaralda

Presencia de *podisus congrex* (stål 1862) (hemiptera: pentatomidae) en relación al manejo de arvenses en el cultivo de aguacate en Risaralda

Sirley Palacios Castro[1]
Beatriz Elena García Vallejo[2]

Abstract

In the last decade, Colombia has been growing in the production of avocado, making itself a production line of major interest in the country and therefore incentivizing the search of ecological alternatives for plague and disease control. This is why this investigation's goal is to determine the presence of the

1 Corporación Universitaria Santa Rosa de Cabal-UNISARC, shirley.palacios@unisarc.edu.co
2 Universidad de Caldas, garciabeatrizelena@hotmail.com

generalist predator *Podisus congrex* (Stål 1862) and its relationship with the frequency of weed management in the avocado crop of Risaralda department. For this, a weekly sampling was carried out throughout the months of March to September 2018, in four avocado crops (each one located in the municipalities of Apia, Belén de Umbría, Pereira and Santa Rosa de Cabal) by observation and collection of *P. congrex* specimens in 5% of the avocado trees. A total of 96 individuals of *P. congrex* were collected, whose presence by the type of weed management:

Mechanical-Semesterly, Mechanical-Quarterly, Chemical-Bimonthly Synthesis and ChemicalSemesterly Synthesis, was 59.4%, 15.6%, 16.7% and 8.3%, respectively. The farm that used Mechanical-Semesterly had a greater presence of the predator compared with the farms that used a more frequent management or that applied pesticides. This suggests the advantages of increasing the diversity of the agricultural landscape through adequate weed management.

Keywords: Biological control, *Podisus congrex*, *Persea americana*, asopinae, weed management.

Resumen

En la última década Colombia está creciendo en la producción de aguacate, volviéndose una de las líneas de producción con mayor interés en el país y por tanto incentivando la búsqueda de alternativas más ecológicas para el control de plagas y enfermedades. Es por ello, que esta investigación tiene como objetivo determinar la presencia del depredador generalista *Podisus congrex* (Stål 1862) y su relación con la frecuencia del manejo de arvenses en el cultivo de aguacate del departamento de Risaralda. Para ello, se realizó un muestreo semanal, en cuatro cultivos de aguacate (cada uno ubicado en los municipios de Apia, Belén de Umbría, Pereira y Santa Rosa de Cabal) durante los meses de marzo a septiembre de 2018, mediante observación y colecta de especímenes de *P. congrex* en el 5% de los árboles de aguacate. Se recolectó un total

de 96 individuos de *P. congrex* cuya presencia por tipo de manejo de arvenses: Mecánico-Semestral, Mecánico-Trimestral, Síntesis Química-Bimensual y Síntesis Química-Semestral, fue 59,4%, 15,6%, 16,7% y 8,3%, respectivamente, presentándose una mayor presencia en la finca con manejo Mecánico-Semestral, que en los predios con manejo más frecuente o con aplicación de herbicidas; sugiriendo las ventajas de aumentar la diversidad del paisaje agrícola mediante el adecuado manejo de arvenses.

***Palabras Clave*:** Control biológico, *Podisus congrex*, *Persea americana*, asopinae, manejo de arvenses.

1. Introduction

The development of avocado crops reflects on the per capita consumption in Colombia that had an increase of 70% in the last five years from 6,1 to 12,3 kg/person/year (Ministry of Agriculture and Rural Development, 2019). This crop is also of economic importance because of its possibilities to satisfy the internal and export market, where they demand that the production is innocuous and without chemical residues; generating a growing interest in the study and management of plagues and diseases associated with this crop (Grisales, Rodríguez, Correa & Tamayo, 2019; Betancourt et al., 2017; Bernal et al., 2014; Kondo et al., 2011). There is a current and renewed interest in biological control as an alternative for conservation and augmentation of natural enemies (Bernal et al. 2014; Cotes, 2018; Barbosa, 1998; Gurr et al., 2000; Pickett & Bugg, 1998). Therefore, maintaining the abundance and diversity of natural enemies, including the manipulation of crop habitats in favo1.r of these, allowing their spatial and temporal persistence is recommended because these allow a natural control of plagues in the agroecosystem (De Bortoli, Otuka, Vacari, Martins & Volpe, 2011; Straub et al., 2007; Barbosa, 1998).

It's estimated that 65% of all families in the suborder Heteroptera are partially or completely composed of predator species (Henry & Froeschner, 1988; Cohen, 2000) and many of them have the potential to biologically control arthropod plagues. Members of the subfamily Asopinae feed mainly on phytophagous larvae that belong to the orders Lepidoptera, Coleoptera and Hymenoptera, and in fact, several species of the families Anthocoridae, Miridae, Lygaeidae, Nabidae, Reduviidae and Pentatomidae (subfamily Asopinae) have been or are being used in augmentative biological control programs in various agro-ecosystems, however, only about 10% of the 300 known species have been studied in detail. The economically important species belong to the genus *Podisus*, *Picromerus*, *Arma* y *Perillus* (De Clercq, Coudron, & Riddick, 2014; Zanuncio et al., 2014; Grazia et al., 2015; LeRoux, 1960; López, Ridgwa & Pinnell, 1976; Khloptseva, 1991; Aldrich, Kochansky, Lusby & Borges, 1991; De Clercq, 2000).

In particular, species of the genus *Podisus* are generalist predators and some species have received attention as potential biological control agents for agricultural pests (Drummond, James, Casagrande & Faubert, 1984, Stamopoulos & Chloridis, 1994; De Clercq, 2000). Thus, associated with the avocado production system in Risaralda, the presence of *P. congrex* (Stål 1862) has been observed, a species reported for forestry in Colombia as a potential biological controller (Madrigal, 2019; Pulgarín et al., 2019).

Only two species of the genus *Podisus*, *Podisus maculiventris* (Say) and *Podisus nigrispinus* (Dallas), have been widely studied because they show a great potential to control populations of phytophagous insects (Saini, 1995; De Clercq, 2000). *P. maculiventris* is the only Asopinae commercially available for augmentative biological control (De Clercq, 2008). However, these generalist predators can and should also be included in classic conservation biological control programs (Bernal et al.,

2014; Cotes, 2018). There is a currently renewed interest in this type of biological control that tends to maintain the abundance and diversity of natural enemies, including the manipulation of crop habitats in favor of these, allowing their spatial and temporal persistence because these allow a natural control of plagues in the agroecosystem (De Bortoli et al., 2011; Straub et al., 2008; Barbosa, 1998). This habitat manipulation includes all those strategies that increase the diversity of the agricultural landscape, among which are the adequate management of weeds. Nowadays, it is considered that the presence of different species of weeds within the crops, has a deep impact in the composition and interactions of the entomofauna of the crop, to such an extent that the predators and parasitoids are more effective in the complex habitats (Blanco & Leyva, 2007) as beneficial insects are more likely to find alternative prey, shelter, breeding sites and sleeping shelters (Zamora et al., 2008). These strategies are part of the Ecological Pest Management, key in the development of Agroecology to allow farmers to be less input-dependent while producing less contaminated food.

This is why this investigation's goal is to determine the presence of the generalist predator *Podisus congrex* (Stål 1862) and its relationship with the frequency of weed management in the avocado crop of Risaralda department.

2. Materials and Methods

Area of Study. The study was carried out in four farms located in different municipalities of the Department of Risaralda, and with avocado crops that were in a productive state (flowering and/or fruiting) and with tree ages between four and six years. In order to know details about the management of weeds, an interview was conducted with each farmer and it was established that the management of weeds was chemical (with chemical synthesis products) or mechanical (with scythe) and with variable frequencies (Table 1).

Table 1. *Characteristics of four farms cultivated with avocado (**P. americana** M.) and selected for the sampling of **Podisus congrex** (Stål 1862) (Hemiptera: Pentatomidae) in Risaralda*

Municipality	Altitude (msnm)	Variety	Type and frequency of management of weeds
Apia	1723	Hass	Mechanical-Semesterly
Belén de Umbría	1258	Papelillo/Santana	Mechanical-Quarterly
Pereira	1417	Hass	Chemical-Bimonthly Synthesis
Santa Rosa de Cabal	1716	Santana/Papelillo	Chemical-Semesterly Synthesis

Field sampling of Podisus congrex (Stål 1862) in avocado crops. In each of the four selected sites, a (weekly) sampling was carried out throughout the months of March to September 2018 for a total of 32 visits, and 5% of the trees per lot were randomly sampled. Each tree selected for sampling was (imaginatively) divided into four quadrants, in which plant structures (stem, branches, and leaves) in the middle and lower parts of the tree were checked for individuals of *P. congrex* (eggs, nymphs, and adults) (based on and modified from Vaissiere et al., 2011). Afterwards, the collected specimens were taken to the Entomology Laboratory of the Santa Rosa de Cabal University Corporation - UNISARC, for their identification.

Statistical analysis. For the evaluation of the field presence of *P. congrex*, the following formula was used:

$$\%\ \text{Presence (relative)} = \frac{\text{No. of individuals of } P.congrex \text{ by frequency of management X 100}}{\text{No. TOTAL of individuals of } P.congrex \text{ in the frequencies of management}}$$

In addition, descriptive statistics using the Excel® program were used.

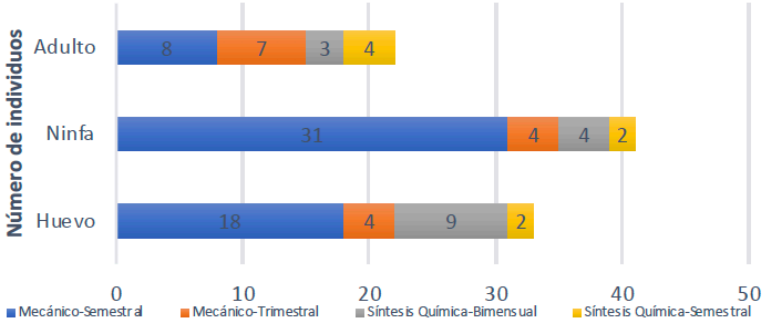
3. Results and Discussion

The collected specimens correspond to the generalist predator *Podisus congrex* (Stål 1862), species that, in Colombia, has only been reported by Madrigal (2019) and Pulgarín et al.

(2019) in forestry as a potential biological controller of *Gonipterus platensis* Marrelli (Coleoptera: Curculionidae).

A total of 96 *P. congrex* individuals were collected from the four sampled sites. This predatory bug was found throughout the avocado production period (from flowering to fruiting) in the four sampled plots, and when differentiated by developmental stages, 33 eggs, 41 nymphs and 22 adults were found (Figure 1).

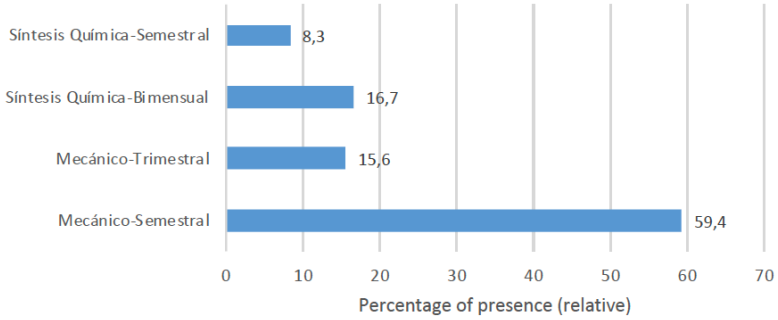
Figure 1. *Number of individuals by developmental stage of* ***Podisus congrex*** *(Stål 1862) (Hemiptera: Pentatomidae) in avocado (****P. americana*** *M.) crops in four farms of Risaralda with differential weed management. (March to September 2018).*



The relative presence of *P. congrex* was higher in the property with Mechanical-Semesterly weed management (59.4%), while it was much lower in the properties with more frequent management (Mechanical-Quarterly), or with herbicide application (Chemical-Bimonthly Synthesis and Chemical-Semesterly Synthesis) (Figure 2), suggesting that herbicide application may be affecting the presence of this predatory bug in the avocado agroecosystem. Regarding this, De Cock et al. (1996) indicate that predators can be indirectly affected by consuming contaminated water. However, it should also be taken into account that agroecosystems present different stochastic events, which include, in addition to the application of agrochemicals, the type of crop and the harvest,

and these can affect the presence of generalist predator species that, even if they are well adapted to the transitory environments created by the crops, can be temporarily affected by such events on a local scale (Symondson et al., 2002).

Figure 2. *Relative presence of* ***Podisus congrex*** *(Stål 1862) (Hemiptera: Pentatomidae) in avocado crops (****P. americana*** *M.) in four farms of Risaralda with differential weed management. (March to September 2018).*

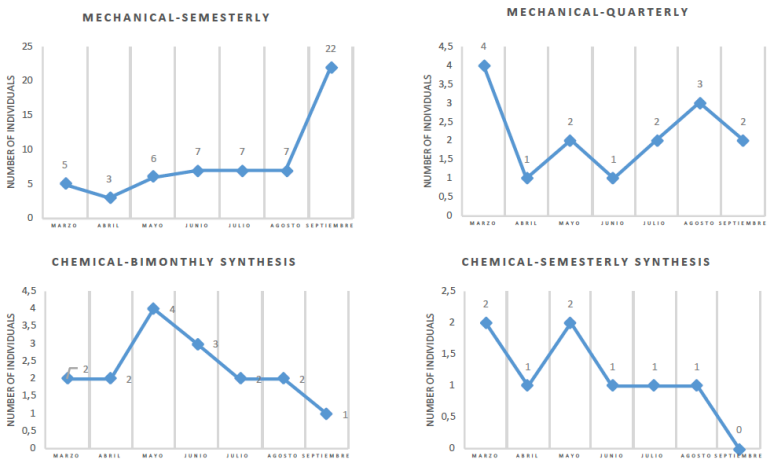


The property with mechanical-semesterly management presented a maximum of 22 individuals collected the last month, making this the type of management with the highest number of individuals collected (Figure 3). This indicates that the presence of weeds is of great value because these habitats are important as alternate sites for hibernation and refuge for some natural enemies, as well as areas with food resources such as pollen or nectar for parasites and predators (Altieri & Nicholls, 2004; 2007).

Sustainability in a production system is due to the adequate combination of agronomic practices carried out on the crop (Rodríguez et al., 2011); This allows weed groups to be considered in the agroecosystem as biological corridors, this means they constitute a natural biodiversity where beneficial insects find shelter and alternative food, and exercise their dominion by attacking the insect pests (Nicholls, 2008; Ryszkowski & Karg, 2007), which indicates

a direct trophic interaction (Norris & Kogan, 2000). Since the survival and activity of many natural enemies depend on resources offered by the vegetation adjacent to the field, this natural vegetation can be manipulated to promote biological control for conservation (Fry, 1995; Van Emden, 1965).

Figure 3. *Population of* ***Podisus congrex*** *Stål in avocado crops (****P. americana*** *M.) in four farms of Risaralda with differential weed management. (March to September 2018).*



The biological control for conservation, is recommended as a strategy that begins by overcoming the paradigm of prioritizing the use of specialized natural enemies (parasitoids) and considering the fundamental importance of the complex of predators as a complementary mechanism of control (Symondson et al., 2002); because of this it is necessary to sustain and increase the presence of *P. congrex* in the avocado crops of the region. In fact, some studies have shown that, in certain cultivation systems, the control exercised by predators is more important than the action of the parasites (Debach & Rosen, 1991; Safarzoda, Bahlai, Fox & Landis, 2014), this is justified by the fact that diversification of the avocado agroecosystem with a wide variety of plant

arrangements (cultivation with weeds, cover crops, biological corridors, among others) is an alternative that generally results in increased environmental opportunities for natural enemies (Altieri, 1994; Altieri & Nicholls, 2004).

4. Conclusions

The first report of the presence of *Podisus congrex* (Stål 1862) in avocado cultivation for the Department of Risaralda is made.

Podisus congrex had a greater presence on the farm with Mechanical-Semesterly management than on farms with more frequent management or herbicide application.

The relative presence of *Podisus congrex* (Stål 1862) by type of pest management: Mechanical-Semesterly, Mechanical-Quarterly, Chemical-Bimonthly Synthesis and ChemicalSemesterly Synthesis, was 59.4%, 15.6%, 16.7% and 8.3%, respectively.

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